PARENTAL SIZE AND CARCASS COMPOSITION OF LAMBS A 34

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The sheep population in the U.S.A. has steadily declined since World War II from approximately 50,000,000 to less than 21,000,000 (U.S.D.A., 1970). The U.S. per capita annual lamb consumption has fallen from 3.3 kg to 1.5 kg over the same period. Meanwhile, total per capita annual meat consumption has risen from 67.4 kg to 82.1 kg. Many reasons could be proposed for this decline in lamb production and consumption including a shortage of qualified labor for sheep production, relatively higher lamb meat prices to consumers, as compared with beef and pork, inadequate market promotion of lamb to consumers and additional factors. Lamb carcasses available from U.S. production have been somewhat more variable in weight and in lean-fat composition than the meat trade would prefer. The lamb producing interests could strengthen their position by developing production programs which would produce a more uniform lamb carcass at the preferred market weights. The objective of this study was to more precisely evaluate the influence of parental size on lamb carcass characteristics and on the chemical composition of the carcasses.

Over 100 years ago, Lawes and Gilbert (1860) determined among other things that fat deposition in sheep carcasses increased with increasing body size. Pallsson and Verges (1952) established that there appear to be growth gradients associated with age and development of sheep. Wallace (1948) confirmed the concept of differential growth rate of various tissues and portions of lamb. McMeekan and Clarke (1942) reported New Zealand lamb had relative increases in bone, muscle and fat of 80, 100 and 240 percent respectively from lighter lamb to heavier mutton carcasses. Clarke and McMeekan (1952) reported the primary difference among the New Zealand quality and weight grades was the relative

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degree of fatness.

Numerous American investigators have reported formulae for estimating percent of trimmed retail cuts in lamb carcasses (Hoke, 1961; Field et al., 1963; Judge and Martin, 1963; Spurlock and Bradford, 1965; Spurlock et al., 1966; Judge et al., 1966; Carpenter et al., 1969; and Smith et al., 1969). Measurements of carcass fat, such as fat thickness over the longissimus and amount of kidney fat individually or in combination with other parameters, has provided the best estimates of carcass meat composition. Whenever there is considerable variation in the lamb population, the investigators found that objective measurements of carcass fat gave high negative correlations with meatiness in the carcass as expressed by carcass cutting tests.

Barton and Kirton (1958) reported a significant relationship between weight and composition of lamb carcasses. They found that when there was a wide range in lamb carcass weight, weight could be used to predict the weight of dissectable carcass components.

Reid et al. (1968a, 1968b and 1968c) have reviewed much of the classical work in body composition of meat animals. Reid et al. (1968a) concluded that there is a strong relationship between body weight and body composition when species and genetic background are considered. Ringkob et al. (1966) substantiated this conclusion when they found that there was a very little change in chemical composition of carcasses from lambs subjected to nutritional levels of considerable variation. When slaughtered at a constant weight the older lambs had a higher percent water and protein content and a lower percent dry matter and fat content than younger lambs. However, these chemical changes were less than one percent per hundred days of age.

Some implications which are strongly suggested from the literature are that (1) lambs of the same genetic background and body weight will have very similar body composition, (2) lambs of similar breeding produce leaner carcasses at lighter slaughter weights than at heavier weights (Ringkob, 1970).

MATERIALS AND METHODS

Sixty lambs were produced for slaughter and carcass study according to an experimental design shown in Table 1.

All sheep were of American breeding from breeds developed for both meat and wool production. The male parents were selected irrespective of their breeds to assure that the males were of great potential genetic difference with respect to mature body size. The small male parent was a 54 kg Dorset ram and the large male parent was a 118 kg Suffolk ram. The female parents were a breed common to the western mountain region of the U.S. commonly described as whitefaced ewes and they varied in body weight from 40 to 88 kg. The mean weight of the group of light female parents was 48 kg and the average weight of the heavy group was 69 kg. Thirty lamb offspring were each randomly allotted to a light slaughter group (36 kg) and a heavy slaughter group (48 kg) with the restriction that all sets of twins be split with one twin member going to each group.

The female parents and their respective lambs were fed and cared for in individual pens. The female parents were fed a pelleted total alfalfa ration except during lactation when they were fed one-half pelleted alfalfa and one-half 16 percent pelleted protein commercial ration formulated for lactating dairy cattle. The lambs were fed a 50:50 ratio of pelleted alfalfa hay and 16 percent pelleted dairy ration throughout the trial. The lambs received the complete milk produced by their mothers until they were separated and thus weaned at twelve weeks of age.

When the lambs reached their specified weights (plus an additional increment to compensate for the anticipated loss of weight from removal of wool and 24 hour pre-slaughter abstinence from feed) they were shorn of wool and withdrawn from feed. Following slaughter, the carcasses were chilled for 72 hours at 1.0 C and cutting tests and chemical analysis of tissues were made. The cutting method used was essentially that of Field et al. (1967) as recommended by the Reciprocal Meat Conference of the American Meat Science Association. The fifth through twelfth rib section, the rack, was frozen and sliced into thin sections, freeze dried to remove all water, and then ground with dry ice in a Wiley mill to obtain a homogenous sample for further analysis. Percent ether extract and ash were obtained using A.O.A.C. procedures (1965). Protein was calculated by difference. Ether extract and protein values were converted to a wet-tissue basis.

RESULTS AND DISCUSSION

Trimmed retail lamb cuts, like those normally presented to American consumers through the conventional marketing procedures, are presented in Table 2 and are expressed as percentage of unchilled lamb carcass weight and according to parental size. This expression of lamb meat yield is most directly related to the kitchen ready cuts as lamb is cooked and served by American families. Within the conditions of this experiment, the difference in male parental size was associated with a difference of 3.9 percent yield of trimmed retail cuts and the difference in the selected slaughter weights, 36 kg and 54 kg, was associated with a difference in trimmed cut yield of 10.3 percent, Table 6. George et al. (1966) compared carcasses from lambs varying in slaughter weight from 33 to 60 kg and recognized that body weight significantly affected meat yields but questioned that the magnitude of the influence of body size at slaughter had much practical significance on trimmed meat yield. The data here reported indicate that differences between slaughter weights of 36 and 54 kg have considerable influence on the yield of trimmed retail cuts (leg, loin, rack and shoulder) expressed as percent of carcass weight.

This study is a practical demonstration of the influences of stage of growth relative to potential mature size at the time of slaughter on composition as discussed by Reid et al. 1968b. In the detailed and more complete statistical analysis of these data, Ringkob (1970) concluded that for the production of lamb carcasses with approximately 0.5 cm of fat thickness over the rib eye, the large ram progeny should be slaughtered at 20 to 25 percent of the sum of their parental weights and the small ram progeny should be slaughtered at 30 to 35 percent of the sum of their parental weights.

The outside fat covering of lamb carcasses offers protection from desiccation during post slaughter chilling and during distribution to retail food stores. However amounts above 5 mm are considered overfat by most United States consumers. The difference in fat thickness associated with sire size and with the slaughter weights used in this study as ahown in Tables 3 and 6, suggest that subcutaneous fat covering, a rather reliable index of carcass lean and fat, can be readily controlled, within desired limits, through controlled breeding and marketing programs. Meat tradesmen are especially concerned over the economic waste from the frequent need to discard excessive waste fat from cuts before retail sale. This removal is costly in both labor and loss of product weight. Tables 4 and 6 show that within the conditions of this experimental study, differences in sire size are associated with trimmed fat losses of 2.7 percent; differences in slaughter weight with 9.0 percent.

The differences shown in protein and ether extract of the untrimmed, wholesale rack, Table 5, are similar to the cut out carcass data for yields of retail cuts and of waste fat. The early report of Hankins (1947) established that the lamb rack was a reliable sample of the composition of total lamb carcass.

There remains a need for definition by the meat trade of the optimum carcass weights and fat thickness for specific markets. With this definition and with sufficient economic incentives, lamb production programs based largely upon parents' size and slaughter weight could readily supply the lamb carcasses specified in such a definition.

The differences in lamb carcass composition associated with the size of parents and the weight of lambs at slaughter are practical demonstrations of fundamental principles of growth and fattening. The same principles likely influence the yield of commercial beef cuts to a similar extent.

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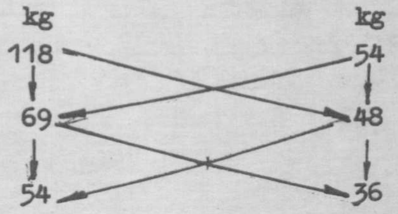
Table 1. General design for production of the experimental lambs used in the study.

Item	Mean body weight of parents at bree ding and of offspring at slaughter
Male parent	
Female parent	
Offspring at slaughter	



Number of lambs slaughtered at different weights

54 kg	30
36 kg	30
Total	60

Table 2. Trimmed retail cuts 1/ expressed as percent of unchilled carcass weight and according to parental size 2/

Lamb group	Number	Parental size: Large ram, large ewe	Large ram, small ewe	Small ram, large ewe	Small ram, small ewe	$\bar{X}$ 3/
		%	%	%	%	
Light (36 kg)	30	74.0	71.6	70.7	68.1	71.1
Heavy (54 kg)	30	64.4	61.5	59.7	57.5	60.8
Mean 2/ for sire progeny			67.9		64.0	

1/ The leg, loin, rack and shoulder trimmed to 5 mm maximum of external fat.
2/ The term parental size refers to the weight of the lamb's dam and sire shortly before the breeding season.
3/ Data on a group average basis and disregarding unequal subclass numbers.

Table 3. Mean thickness of subcutaneus fat over the <u>longissimus</u> muscle at the 12th rib.

Lamb GROUP	Parental size				
	Large ram		Small ram		
	Large ewe	Small ewe	Large ewe	Small ewe	$\bar{X}$ 1/
	CM	CM	CM	CM	
Light	.25	.46	.41	.63	.43
Heavy	.89	1.29	1.02	1.73	1.22
Mean for sire progeny	.72		.94		

1/ Data on a group average basis and disregarding unequal subclass numbers

Table 4. Mean amount of fat removed form the carcass for the preparation of retail cuts according to parental size.

Lamb group	Parental size								
	Large ram				Small ram				
	large ewe		small ewe		large ewe		small ewe		$\bar{X}$ 1/
	kg	%	kg	%	kg	%	kg	%	
Light	.73	3.6	1.36	6.7	1.09	5.5	1.54	8.8	6.2% 2/ 1.18kg
Heavy	3.90	12.3	4.80	14.7	5.17	15.6	5.94	18.1	15.2% 4.95 kg

1/ Data on a group average basis and disregarding unequal subclass numbers

2/ % reffers to the amount of fat trim as percent of the carcass weight

Table 5. Percent of protein and ether extract in the untrimmed wholesale rack (6 through 12 rib section) according to parental size.

	Parental size								
	Large Ram				Small ram				
	Large ewe		Small ewe		Large ewe		Small ewe		
Lamb group	Protein	E.E.	Protein	E.E.	Protein	E.E.	Protein	E.E.	$\bar{X}$[1]
	%	%	%	%	%	%	%	%	
Light	15.7	27.5	14.1	36.4	14.7	32.2	13.7	38.0	14.6% protein 33.5% E.E.
Heavy	11.8	48.1	10.6	53.2	11.5	50.7	9.6	57.0	10.9% protein 52.3% E.E.
Mean for sire progeny				13.3% Protein 41.3% E.E.			12.4% Protein 44.5% E.E.		

[1] Data on a group average bases and disregarding unequal subclass numbers

Table 6. Summary table of differences in trimmed retail yield, fat trim and subcutaneus fat thickness at 12th rib.

Difference	Trimmed retail yield	Fat trim	Fat thickness
	%	%	%
Large sire less small sire	+ 3.9	- 2.7	- .22
Light slaughter weight less heavy slaughter weight	+10.3	- 9.0	- .79